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A NOTE ON THE METAMORPHOSIS OF THE MUSSEL *LAMPSILIS LÆVISSIMUS*.¹

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While making a collection of the glochidia of various species of mussels used in this laboratory certain observations have been made which prompt the publication of a preliminary note on the peculiar type of glochidium seen in *Lampsilis lævissimus* and other species, and the metamorphosis during the period of parasitism.

I. TYPE OF GLOCHIDIUM AND POSSIBLE SIGNIFICANCE.

The glochidium of *Lampsilis alatus* has been observed by Lefevre and Curtis,² who describe it as an "axe-head" glochidium. "This possesses hooks which are not homologous with those of the anodonta type and is to be regarded as more nearly related to the hookless forms, an interpretation which is borne out by the fact that the 'axe-head' can be readily imagined as a modification of the glochidial outline seen in some species of *Lampsilis*, which, like *subrostratus*, show an approach to a rectangular outline."

This glochidium (Figs. 3 and 3a) is certainly of a very specialized form. In our laboratory we have observed an almost exactly similar glochidium in *L. capax* (Figs. 4 and 4a), while in *L. lævissimus* (Figs. 1 and 1a) the same shape is observed but the hooks are wanting. It is remarkable that a larva of so specialized a form should be found in two species such as *alatus* and *capax*, the adult forms of which are so extremely opposed in general shape; *alatus* is one of the most compressed forms in the genus, while *capax* is the most inflated (Figs. 4b and 4c).

L. lævissimus (Figs. 1b and 1c) and *L. gracilis* are forms suggestive of *alatus* in the compressed character of the shell. They are somewhat more compressed than *alatus* and are much thinner

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² "Reproduction and Parasitism in the Unionidæ," *Jour. Exp. Zoöl.*, Vol. IX., No. 1, p. 94.

shelled. These two species seem almost to intergrade (in form of shell) so that one sometimes hesitates in the identification of a specimen of intermediate form. On the other hand, the glochidia of these two species show a striking contrast. The glochidium of *gracilis* (Figs. 2 and 2a) is oval-pear-shaped and very similar to that of *ligamentinus* or *ventricosus*, or to what we generally regard as a typical form; while that of *lævissimus* (Figs. 1 and 1a) is of the "axe-head" type. Comparison of Figs. 1a and 2a may suggest, however, that the two species are not so dissimilar as at first appears, and *lævissimus* may be thought of as intermediate between *alatus* and *gracilis*.

The remarkable fact, yet, is that *capax* should have this type of glochidium. *Capax* has always been grouped with *ventricosus* and *ovatus*, but *ventricosus*, at least, has a glochidium of the usual form. Whether the greater significance be attached to resemblances in larval form or in adult form, it is a suggestive revelation of the adaptability of fresh-water mussels and the inadequacy of superficial diagnosis. Undoubtedly in the classification of fresh-water mussels an entirely undue stress has been laid upon characters of a superficial nature. The ultimate system will be based on a much more thorough analysis of the actual anatomy of mussels in young and adult stages than has ever been attempted in systematic work on this group. We have not yet a sufficient knowledge of the comparative anatomy of glochidia to judge of their relative value in the study of relationships, but certain considerations derived from the present case are sufficiently striking to be recorded for their suggestive value.

Ventricosus is certainly closely related to *ligamentinus* and *luteolus*, as judged by the external form. The glochidia, too, are much like those of *ligamentinus*. The adult form is specialized most noticeably in being very inflated. *Gracilis* is specialized in a different way, being exceedingly compressed laterally and having compressed teeth; *lævissimus* (Figs. 1b and 1c) is a more extreme form of the *gracilis* type, the teeth are more blade-like, while the shell is equally compressed from side to side and has well-developed wings. The glochidium, while suggestive of *gracilis* (which is of the "typical" form), is of the "axe-head" form. The adult *alatus* is of somewhat the same compressed

form, broadly winged, and with "axe-head" glochidia still further modified by the development of hooks. *Capax* has the same type of glochidium, but what of the adult form (Figs. 4*b* and 4*c*)?

In external shape *capax* and *ventricosus* are so closely alike that it has sometimes been doubted if the two species were properly separable. However, the species *capax* is now universally accepted, for the reason that *capax* is clearly distinguishable from *ventricosus* in: (1) the polished almost rayless character of its epidermis, (2) the compressed form of the teeth, and (3) in the relative thinness of its shell, which is inclined to pinkness in color of nacre. Now these, it is significant to remark, are all characters of *lævissimus*. In fact, (1) above is the most certain means of distinguishing *lævissimus* from *gracilis*.

If, then, we were to draw an inference from the glochidia as to a relationship between *lævissimus*, *alatus* and *capax*, there would be strong corroborative evidence in the adult characters, in spite of the fact that *lævissimus* and *capax* are the two extremes in degree of inflation. The similar degree of inflation of *capax* and *ventricosus* would offer only a striking instance of convergence in one character.

2. CHANGE OF FORM DURING PARASITISM.

The change undergone by *Lampsilis lævissimus* during parasitism is most striking. As a general rule, it has been held that there is practically no growth in size during the period of parasitism—simply a metamorphosis from glochidium to young mussel in rudimentary form. Our observations show a notable exception to this general rule.

While examining the gills of a specimen of the sheep's-head, *Aplodinotus grunniens*, several specimens of encysted glochidia were found in an advanced stage of development. The infection occurred in nature, so that the age of the mussels cannot be stated.

Figs. 5, 6 and 7 show not only the striking change in form, but the enormous increase in size as well. Fig. 5 shows a specimen in side view; the "axe-head" glochidium shell is evident, but the mussel is now nearly circular in outline and several times larger than the glochidium. The specimen shows considerable

inflation. Fig. 7 shows the dorsal aspect of a more advanced specimen; the degree of inflation is apparent; the glochidial shell is insignificant in size as compared with the mussel; it is like a narrow saddle which extends only about half way over the side of the mussel shell. The position of the glochidial shell valves in Figs. 5 and 6 will be better understood from a comparison with this figure. The specimen of Fig. 6 is viewed from a ventro-lateral aspect. The following measurements (in decimal parts of millimeter) were made from the specimen represented by Fig. 6:

Length of glochidium.....	0.095 mm.
Width (height).....	0.15 mm.
Length of mussel.....	0.320 mm.
Width (height) of mussel.....	0.215 mm.

The mussel, as compared with glochidium, is nearly three and one half times as long and nearly one and one half times as wide. It is evident that there must have occurred a material increase in the size of the cellular cyst of the tissue of the host which encloses the young mussel.

The shape of the mussel in the stage shown by Fig. 7 led to the suspicion that the glochidium was of *capax* instead of *lævis-simus*, but the form of the glochidium is that of *lævis-simus*, and there is no sign of teeth on the shell.

It is not known that such a growth in size and alteration of form occurs in any other species during the period of parasitism. What further change in form or growth in size would occur before the liberation of the mussel cannot be determined without additional material, not now available.

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